

Serial No. 09/783,002

- 2 -

Art Unit: 2633

In the Specification:

✓ Page 2, please replace the paragraph spanning lines 11-17 (paragraph 5) with:

A1  
The photonic switch and cross-connect PSX according to the present invention includes means for demultiplexing an optical signal into channels, photonic switch fabric, means for monitoring before and after the photonic switch fabric, means for protecting channels responsive to the monitoring means, means for compensating for channel impairment ~~signal~~ signal responsive to the monitoring means, and means for multiplexing a plurality of channels into an optical signal.

✓ Page 3, please replace the paragraph spanning lines 16-21 (paragraph 15) with:

A2  
Node 16 is shown in greater detail, coupled to fiber 50, and having input line function 52, photonic switch fabric 54, output line function 56, coupled to fiber 58. Also included are a signal processor 60, content processor 62, and OA&M 64 interconnected as shown in the figure. An analog, digital ~~lambda~~ lambda converter 66 provides for add/drop, wavelength conversion and electronic cross-connect functions.

Serial No. 09/783,002

- 3 -

Art Unit: 2633

Pages 3 and 4, please replace the paragraph spanning page 3 line 35 through page 4 line 9 (paragraph 17) with:

AB  
Operation will now be described with reference to FIG. 1 showing a high level view of a photonic network. It includes ~~of~~ collector networks or access networks 42-48 which handle the sub-wavelength aggregation into wavelength level traffic, the wavelength-level traffic emerging at the trunk ports of a router, for instance. The wavelength level traffic, whether it be aggregated traffic from a router or switch or whether it be a longer-term or higher bandwidth service directly fed to/from an end user, is encapsulated in a wavelength wrapper, for example at electro-optical device 32, or a similar solution to allow a reliable end-to-end path to be established. The purposes that the wavelength wrapper (a wavelength-level overhead channel added to the payload) may provide include:

Page 4, please replace the paragraph spanning lines 29-34 (paragraph 25) with:

AA  
The individual wavelength finds its way to the required ~~and~~ end destination by establishing end-to-end optical paths at the wavelength level by a process of concatenating individual optical spans. This is achieved by use of photonic switches (14, 18, 24) which cross-connect individual wavelengths from any given input span to the appropriate output spans on a wavelength-by-wavelength or alternatively wavelength group-by-wavelength group basis.

Serial No. 09/783,002

- 4 -

Art Unit: 2633

Pages 5-6, please replace the paragraph spanning page 5 line 36 through page 6 line 4 (paragraph 30) with:

AB 4. The photonic switch introduces a method of "randomly" changing the combinations of optical impairments between transmitters and receivers and changing transmitter/receiver relationships. Hence, a short path between a relatively local transmitter and a given receiver may suddenly be replaced by a path to that receiver that originates from a long distance, from a far transmitter. This can introduce ~~problem~~ problems in each of two areas:

Page 6, please replace the paragraph spanning lines 23-30 (paragraph 35) with:

AB The photonic node 100 includes N inputs for fiber 102, an optical amplifier 104, a demultiplexer 106, a first protection function 108, a photonic switch fabric 110, a second protection function 112, a channel impairment compensation function 114, a multiplexer 116, an optical amplifier 118, an output for fiber 120, and electro-optics device 122. Support functions include ~~fast and slow line scanners 124 and 126, wrappers readers 128, connection comparison 130, channels performance monitors 132, OAM&P processor 134,~~ a connection map 136 and a control processor 62 ~~138~~.

Serial No. 09/783,002

- 5 -

Art Unit: 2633

Pages 6-7 please replace the paragraph spanning page 6 line 31 through page 7 line 17 (paragraph 36) with:

*AB*

In operation, the central optical switching core 110 provides an array or arrays of optical cross-points, to provide the actual switching of the optical path, which may be at the individual wavelength level, the wavelength group level or both. This core, comprising a protected main fabric and a 1:1 or 1:N protecting fabric, has a control system 62 to control it, an OAM/integrity system 134 to verify/manage the node, protecting elements to mitigate the effects of failures, input and output "line card" functions between an individual fiber 102 ~~106~~, 120 and the switch core 110, a wavelength conversion and add-drop function 122, and compensation elements 114 to correct for optical impairments occurring in the switch or in the signals reaching the switch. The wavelength conversion function is provided to convert wavelengths that can no longer be propagated onwards due to "wavelength blocking", to regenerate optical signals that have been transmitted through too many impairments in reaching this node to permit them to be propagated onwards without "clean-up". We will now "walk through" the optical path through the switch and then cover off how this optical path is controlled, managed and verified. An incoming optical signal consisting of a multi-channel WDM feed enters the node at A. This signal may have traveled a long distance through many amplifiers, filters and switch nodes, thereby accumulating a large level of degradation or it may be relatively local (and hence clean) source. The signal enters the switch node by passing straight through a protection switch element (Protection Switch 1). The purpose of this protection switch element is to provide the line-side component of the per-fiber tributary protection switching function, the switch-core side tributary switching function

Serial No. 09/783,002

- 6 -

Art Unit: 2633

being provided by changing the connection map of the main switch itself to pick up the feed from the protection tributary path.

Page 8, please replace the paragraph spanning lines 11-30 (paragraph 39) with:

The optical signal components, now at the granularity at which they will be switched, are output to the main switch fabric, from the WDD outputs 106 ~~105~~, via a protection switch mechanism 108 (Protection Switch 2). This protection switch mechanism 108 provides the protection for failures of all (1:1 protection) or part (1:N protection) of the switch core. In general, if the main fabric 110 is a single stage, monolithic structure, then 1:1 protection switching is needed, whereas, if the switch core can be partitioned into similar, provisionable non-interdependent building blocks, then 1:N protection switching can be deployed. The protection switch 108 (Protection Switch 2) operates in conjunction with Protection Switch 3 (112) to bypass a failed main fabric/failed main fabric module, by re-routing the traffic to a protecting fabric or one or more protecting fabric modules. The optical signals are switched in the main fabric 110 and then output from that fabric. The output optical signals are passed through a series compensation blocks 111 which correct/reduce the range of impairments on a per-wavelength or per-wavelength group basis (depending up on the granularity of the switch), before being fed to the output WDM 116 ~~114~~. These compensators operate under the control of a centralized Impairment Control Block 114 ~~112~~, which may consist of a Power Spectrum Equalizer for amplitude control, as Chromatic Dispersion Equalizer, etc, and which may have shared functionality with the Switch Path Integrity Check system.

Serial No. 09/783,002

- 7 -

Art Unit: 2633

Pages 8-9, please replace the paragraph spanning page 8 line 31 through page 9 line 2 (paragraph 40) with:

A7  
The output WDM 116 ~~114~~ module combines the outputs from each of the switch ports that are destined for a given output fiber and there the WDM signal is output to line 120 via an optical post-amplifier 118 and an asymmetric power splitter, typically passing .about.95% of the output out of the node to line and returning .about.5% into the Impairment Control Block 114 is centralized and controls the per-granular element compensation arrays as well as the optional input bulk compensation arrays, a shared sophisticated scheme can be used to remove the vast majority of the optical impairments in the output optical signal, including the output WDM 116 ~~114~~ and post-amplifier 118.

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Serial No. 09/783,002

- 8 -

Art Unit: 2633

✓ Page 9-10 please replace the paragraph spanning page 9 lines 36 through page 10 line 21  
(paragraph 59) with:

These signals, along with the aforementioned impairments, are switched by the protected main fabric 110. This fabric contains an array of switching cross points, in a simple or quite complex topology, which operate under control of the control processor to set up the required connection paths. More on this control system later. The optical signals are switched through to main fabric output ports which correspond to the appropriate wavelength port on the appropriate output tributary card to connect to the correct output fiber 120. But these signals do not go straight through to the output WDM (wavelength division multiplexer) 116 ~~114~~. Instead, they pass through a per wavelength/per granular element compensation block 111. This block removes/reduces the optical impairments that have randomly accumulated in the individual optical carriers (or will accumulate before they exit the switch). There are many more contributors to individual (per wavelength) variations in amplitude than there are for chromatic dispersion (since chromatic dispersion primarily occurs in the optical fiber, where all of the wavelengths are subject to a more-or-less similar degradation) and hence per wavelength amplitude compensation is of prime interest. However, since in a long system, errors will build up in the way the bulk compensators treat non-spectrally flat chromatic dispersion, and we will mix signals from different chromatically dispersive (and differently compensated) paths, a need for per-wavelength chromatic dispersion is expected to arise, especially in ultra long haul systems. The sources of amplitude error (present at the output of the node, where the optical signal is sampled for analysis) that can be removed with the per wavelength compensation block include:

Serial No. 09/783,002

- 9 -

Art Unit: 2633

✓ Pages 11 and 12, please replace the paragraph spanning page 11 line 19 through page 12 line 15 with:

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The input WDM signal taps are used to feed a portion of the signal to an array of receivers in the input to the signaling processing block 60. This signaling processing block 60 extracts the per channel signaling in the wavelength wrapper in order to allow the incoming signals to request their own paths through the network. In order to facilitate signaling information recovery without a large array of very high speed receivers at the signaling extraction point, specific arrangements are made in the format of the wavelength wrapper. These allow the wrapper reader to use an array of lower bandwidth, line protocol/bit rate--independent (but not wrapper-data-rate independent) receivers that, being narrowband, are more sensitive and permit the use of asymmetric splitting of the optical signal at the input split point. The d.c. voltage level from these receivers provides a measure of the per-wavelength optical power (~~the wrapper reader consists of a WDD device and an array of low bandwidth receivers, although various scanning techniques can also be used, to reduce the equipment complexity~~). This d.c. voltage level is fed to the PSE in the Impairment Control 114 and is used to set the gain/loss of the input amplitude controllers (amplifiers or attenuators). The extracted signaling information is passed to the control processor 62 and/or OAM processor 134. In this case it will be assumed that the wavelength wrapper covers channel is passed to the OAM processor 134, where it is decoded/demultiplexed, OAM information is retained and the signaling information is passed to the control processor 62, which, after suitable decision/processing, uses the data data to update its connection map 136. Note that there are a large number of variations to the theme of self-threading networks and auto-discovering switch-nodes and it is not possible to cover them all



Serial No. 09/783,002

- 10 -

Art Unit: 2633

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here. The OAM processor 134 communicates with a Network Manager (NM) 40 covering a plurality of Switch Nodes and which provides the overall network control, integrity and provisioning functions. Thus, for node functions the OAM processor 134 communicates with the NM 40, and the information that the OAM processor 134 receives from the wavelength wrapper is primarily related to the quality, integrity, class of service/type of circuit of the wavelength contents, along with routing/origin/destination of that wavelength. Other blocks include the dispersion compensation measurement block and the calibration block 111.

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Serial No. 09/783,002

- 11 -

Art Unit: 2633

Pages 12-13, please replace the paragraph spanning page 12 line 26 through page 13 line 15 (paragraph 75) with:

A10

The dispersion compensation measurement block ~~132~~ 135 consists of an optical switch 137 to connect it to the appropriate fiber (input or output), feeding a low noise optical amplifier with a gain roughly equivalent to the loss in the splitter and switch, plus 6-7 dB. The output of the amplifier is fed into a WDD 106 and a switch selects one of the transmitted wavelengths and feeds it to a receiver via three alternating paths. One of these paths is a straight-through path, the other two go via dispersive media. One of the paths goes via a "positive" dispersive medium, most likely a coil of appropriate fiber, whilst the other path goes via an approximately equal and opposite "negative" dispersion medium, likely to be a coil of a different form ~~from~~ of fiber (although other structures such as optical filters, "broken" Bragg gratings, etc. could also be used, with some limitations). The output of the receiver is fed to two band-pass ~~band-pass~~ filters, one centered at relatively low frequencies, the other at relatively high modulation frequencies (and may have to be adaptive depending on the throughput signal). This arrangement allows us to measure the relative signal spectral intensity at high frequencies relative to low frequency. The high frequency spectral intensity is maximized when dispersion is zero so the three paths allow a measurement of the "sign" of the dispersion error (via the "positive", "negative" paths) and a confirmation of a true cancellation (by packing the center path without compensation). This can be done at one or a few wavelengths on the input to minimize the input bulk dispersion, and/or can be done on the output to reduce/eliminate the output dispersion. The next block is the Test/Calibration block 139. The Impairment Control 114 with its associated Dispersion Compensation measurement unit, Power Spectrum equalizer, etc. is a complex sub-system and

Serial No. 09/783,002

- 12 -

Art Unit: 2633

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could be a source of error/unreliability itself. Hence a Test/Calibration block 139 oversees its  
operation and provides an auto-calibration of its complex optical paths.

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